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| APPLICATION NO.  | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/588,833   | 09/02/2008  | Charles M. Lieber    | H0498.70217US02     | 4453             |
| 86110 7590 01/20/2010<br>Harvard University & Medical School<br>c/o Wolf, Greenfield & Sacks, P.C.<br>600 Atlantic Avenue<br>Boston, MA 02210-2206 |             |                      |                     |                  |
| EXAMINER   |             |                      |                     |                  |
| WOLVERTON, DAREN A   |             |                      |                     |                  |
| ART UNIT   |             | PAPER NUMBER         |                     |                  |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

# Office Action Summary

**Application No.**

10/588,833

**Applicant(s)**

LIEBER ET AL.

**Examiner**

DAREN WOLVERTON

**Art Unit**

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 13 October 2009.  
2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 126-134 and 137-145 is/are pending in the application.  
4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.  
5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.  
6) ☒ Claim(s) 126-133 and 137-145 is/are rejected.  
7) ☒ Claim(s) 134 is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.  
10) ☒ The drawing(s) filed on 09 August 2006 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892)  
2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)  
3) ☒ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date 10/13/2009, 11/23/2009  
4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_  
5) ☐ Notice of Informal Patent Application  
6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Claim Objections*

Claim143 is objected to because of the following informalities: the claim omits a transition word (a minor grammatical error). Appropriate correction is required. The suggested correction is: "The method of claim 140 further comprising diffusing at least a portion ..."

### *Claim Rejections - 35 USC § 102*

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 126-133 are rejected under 35 U.S.C. 102(b) as being anticipated by Hu et al. (US 6,413,802) (*Hu* hereinafter).

**Regarding claims 126, 132, and 137,** *Hu* discloses, in FIG. 1 and FIG. 1E, a method, comprising: providing (see FIG. 1) a semiconductor nanoscale wire 8 (called a silicon fin or channel by *Hu*, note that the fin is disclosed as having sub-lithographic dimensions in column 3, lines 54-55, having a preferred width less than the channel length in column 2, lines 25-31, and the channel length is disclosed as being below 100nm in column 1, line 26, and thus *Hu* discloses that the fin is a nanowire with a smallest dimension of less than 100 nm); patterning (see FIG. 2E) a mask (which

comprises the spacers 24 and the gate) on the nanoscale wire 8 to define at least a first portion not covered by the mask and a second portion covered by the mask (shown in FIG. 2E); and siliciding (column 4, lines 36-45) the first portion but not the second portion. Note that one of ordinary skill in the art at the time of the invention would understand the self-aligned siliciding process to include: depositing a bulk metal and annealing to cause the bulk metal to diffuse into the portions not protected by a mask, and therefore *Hu* also discloses the remaining limitations of the claim.

**Regarding claims 127 and 133,** *Hu* further discloses, in column 3, lines 42-48, that the nanoscale wire 8 is a single crystal silicon (as only single crystal silicon can have a (100) orientation).

**Regarding claims 130-131,** *Hu* further discloses, in column 4, line 45, that the metal silicide comprises nickel silicide (which is formed from the diffusion of nickel, a transition metal)

**Regarding claims 140-143,** note that *Hu* as discussed in the above rejection of claims 126-128 and 131, discloses all the limitations of these claims.

Claim 138 is rejected under 35 U.S.C. 102(e) as being anticipated by *Hu* as evidenced by Deng et al. ("Silicidation process using NiSi and its device application") (*Deng* hereinafter).

**Regarding claim 138,** *Hu* discloses all of the limitations of claims 126 and that the first region is nickel silicide (column 4, line 45) but does not disclose that the first region has a resistivity of less than about 60 microOhm cm.

*Deng*, in FIG. 1, discloses that the resistivity of nickel silicide is less than 60 microOhm cm and therefore it is inherent that the nickel silicide in the invention of *Hu* has a resistivity of less than 60 microOhm cm.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 128-129 and 144, are rejected under 35 U.S.C. 103(a) as being unpatentable over *Hu* in view of *Deng*.

**Regarding claims 128-129 and 144-145**, *Hu* discloses all of the limitations of claims 127 and 143 but does not disclose that the metal (nickel, see column 4, line 45) and the silicon have a stoichiometric ratio after diffusing.

*Deng*, in the last paragraph on page 8048, discloses that NiSi, which has a one to one stoichiometric ratio, is formed in the conventional silicidation process.

Therefore, in view of *Deng*, it would have been obvious to one of ordinary skill in the art at the time of the invention to create a 1:1 stoichiometric ratio of nickel to silicide thereby forming NiSi.

One of ordinary skill in the art at the time of the invention would be motivated to do this in order to reduce the film resistivity of the nanowire (see FIG. 1 of *Deng*).

Claim 139 is rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over *Hu* as evidenced by *Wu* et al. ("Single-crystal metallic nanowires and ...") (*Wu* hereinafter)

**Regarding claim 139**, *Hu* discloses all of the limitations of claims 126 but does not disclose that the first region is able to carry a current density of at least about 108 A/cm<sup>2</sup>.

*Wu* discloses (page 62, first column, last paragraph) that similarly created nickel silicide nanowires of comparable dimensions can handle approximately 3x10<sup>8</sup> A/cm<sup>2</sup>. Though the current density is limited by the failure of the structure, which will vary based on the exact details of layout and fabrication, it is probably inherent that the maximum current density will be at least about 108 A/cm<sup>2</sup> above as evidenced by *Wu*.

However, even if it is not inherent, the claim would still be prima facie obvious as increasing the maximum current density of a device allows it to handle larger currents without being destroyed, and it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

#### ***Allowable Subject Matter***

Claim 134 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: the prior art of record, either singularly or in combination, does not disclose the combination of limitations including depositing a metal for the formation of a silicide over a photoresist mask. In the claim, because the first and second regions are being defined by the photoresist mask, the mask must remain during the deposition of the bulk metal which is in contrast to the normal silicidation process which uses a photoresist to pattern a non-photoresist mask (such as oxide or nitride) that blocks areas from contacting the bulk metal (the photoresist being removed prior to the bulk metal formation).

#### ***Response to Amendment***

The declaration filed on 10/13/2009 under 37 CFR 1.131 is sufficient to overcome the Hareland et al. (US 6,897,098) reference.

#### ***Response to Arguments***

Applicant's arguments, filed 10/13/2009, with respect to the objections to the claims and the objections to the drawings have been fully considered and are persuasive. The objections of the action dated 06/12/2009 have been withdrawn.

Applicant's arguments, filed 10/13/2009, with respect to the rejection(s) of claim(s) 126-134 and 137-145 under Hareland et al. (US 6,897,098) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Hu et al. (US 6,413,802).

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DAREN WOLVERTON whose telephone number is (571) 270-5784. The examiner can normally be reached on Monday to Thursday from 9:30 a.m. to 3:00 p.m., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Landau can be reached on (571) 272-1731. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/D. W./  
Examiner, Art Unit 2813

/Matthew C. Landau/  
Supervisory Patent Examiner, Art  
Unit 2813

DW